

CONCEPTUALIZING THE MULTIPLICITY OF INTEGRATION

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Abstract. Integration of complex socio-technical networks is the goal and challenge for today's organization. Surprisingly, such a central term 'integration' is highly ambiguous and has multiply meanings. In this paper we expose the ambiguity of the term 'integration' and propose an interdisciplinary analytical perspective how integration activities can be analysed and explained. We conclude that further interdisciplinary research on integration activities is required.

1. Introduction

Today, organizations operate in highly complex and continually changing socio-technical networks. One of the key characteristics of such networks is integration. Surprisingly, the term 'integration' has multiple and misunderstood meanings [13]. It spans across different research fields and can be conceptualized in different abstraction levels, for instance, integration of technological components or organizational integration. Considering the technical approach to integration, there are different levels of integration [21] and different approaches to integration [15]. Considering that integrated technologies are used in complex social environments, there is a need to consider "interaction between the engineering detail of the technical system and the related dynamics of the surrounding social arrangements" [3, p.3]. Socio-technical analysis concludes that integration activities are complex and lead to various side-effects [14]. Alternatively, a process perspective on integration is also proposed [12]. This perspective requires seeing organization as a composition of processes, which have cross-functional and cross-organizational character. Despite of existing variety of perspectives, approaches and methods, integration is complex and difficult to achieve in practice [5, 21, 29, 33]. Thus, we argue, that in order to better understand the process and the consequences of integration activities, interdisciplinary analytical lens is required.

This paper provides a review [36] and interpretation [17] of diverse literature on integration. Research process was inductive one. We studied existing literature with the primary aim to get acquainted with existing perspectives how integration efforts can be analysed and explained in organizations and identify future research directions.

Consequently, the main purpose of this paper is to illustrate existing ambiguity related to term 'integration' and outline a taxonomy how IT related integration activities could be analysed and explained.

The paper is organized as follows. The next section briefly presents various reasons why organizations pursue integration. The following section presents existing ambiguity of the term 'integration'. In the penultimate section, the taxonomy of integration is conceptualized. The final section discusses analytical implications how to analyze and explain integration activities and argues that more interdisciplinary research on integration activities is required.

2. Why integration?

Today, every organization has to transfer information and share knowledge across functional and organizational borders. It is assumed that integration is prerequisite for every organization rather than an option. Movement towards 'seamless' integration is identified in different industries, such as health care [6], ship classification [29], e-government [2], and oil and gas industry [23].

From management perspective, integration is seen as a mean to cut costs and improve efficiency [21]. For instance, health care organizations aim at seamless integration, which "depends critically on the ability to share information easily between care providers" [12, p.49]. Integration in such case can also be conceptualized as a strategy to obtain higher control over organizational resources [14].

Information redundancy and technological fragmentation are another aspects that integration activities aim to eliminate. For instance, monolithic approach, which concerns such structures as ERP, aims to centralize all information in one central repository

and “streamline the data flow between different functions in an organization” [20, p.56]. Alternatively, in order to cultivate local communities and specific ways of working, distributed strategy can be adopted. Both approaches require particular level of standardization and aim to enable seamless share of information in various time and space dimensions.

Business process perspective, which emerged in the 90ies, strongly motivates towards integrated organization model as well. According to [4] instead of thinking about different functions and departments, cross-functional customer-oriented process perspective should be adopted. Accordingly, particular activity should be conceptualized as a process – integrated set of activities delivering particular product or services for customer. According to [37, p.30-31], “Process integration allows multiple business units to provide single interface to a customer or to move seamlessly from one function (for example, sales) to another (for example, service)”. Therefore, the ideal (integrated) organization would streamline business processes and operate without redundant operations.

Another factor, which requires adopting integrated organization model, is compliancy with regulatory requirements. For instance, Sarbanes-Oxley Act requires certifying not only financial figures, but also processes that generate these figures. Integration, which supports process automation and integration, can be seen as a remedy to achieve required compliance [9, p.246].

3. Ambiguity of integration

The above outlined arguments towards seamlessly integrated organization are clear and promising. However the term ‘integration’ is ambiguous and has multiple and misunderstood meanings [13]. The term ‘integration’ spans across different research fields and can be conceptualized in different abstraction levels, for instance, integration of technological components or seamless organizational integration. The former concerns integration of several technologies, while the latter concerns how technologies are integrated with existing organizational contexts. Below, several perspectives on integration are provided, they highlight existing ambiguity:

- Linthicum [21, p.1] gives extensive account on application integration and outlines that “application integration is a strategic approach to binding many information systems together, at both the service and information levels, supporting their ability to exchange information and leverage processes in real time”.
- Another technical perspective views integration as “the process of combining software components, hardware components or both into an overall system” [16, p.41].
- Shore [30, p.102] is concerned with enterprise integration across globally distributed service organization. Accordingly, “the goal of enterprise

integration – to create a shared information environment that supports the delivery of products and services”. Moreover, “enterprise integration must address technological/business process issues and organizational management issues” [30, p.102].

- Considering integration efforts in health care, Leatt and Guerriere [19, p.14] outline that “integrated healthcare focus on the coordination of health services across the continuum of care, as well as the collaboration among providers and provider organizations in the delivery of health services”. Such an integration is achieved by horizontal (integration of similar services between different organizations) or vertical integration (integration of different organizations under one management umbrella) [19].
- According to Hasselbring [15], integration is achieved in three different levels: inter-organizational process, enterprise application integration and middleware integration.

These perspectives illustrate the ambiguity related to the term ‘integration’. Traditionally, the term ‘integration’ is associated with technical issues, such as how to enable information transfer between different IS. The above presented quotes illustrate that such a perspective is now complemented with business processes, services, communities or existing social arrangements. Such a diversity illustrates that the term ‘integration’ needs to be conceptualized in a more precise manner. In a recent contribution Gullede [13, p.5] aims to “yield clarity on a key term [integration] that is frequently used in information systems research”. Surprisingly, this contribution mainly focuses on technical solutions and distinguishes between monolithic and distributed types of integration. No attention is given to the social dimension, or to be more precise, to the relationship between the technical and the social, already acknowledged in [10]. An interesting perspective, which tries to bridge technical and social dimensions, is outlined by Lee [20, p.60]:

“True enterprise integration means both technical and behavioural integration. It is not simply integrating different systems, applications or business processes dispersed across an enterprise. It is integrating structural changes, different behaviours, and various information systems in an enterprise”.

However systematic account on integration is lacking. Therefore, there is a need to acknowledge various approaches to integration and develop a taxonomy, which represents integration efforts in complex and dynamic socio-technical environments. The next section presents the taxonomy of integration, which is seen as a possible direction to theorize integration activities in organizations.

4. Conceptualizing the patterns of integration

4.1. Elements of organization

According to [28], organizations can be seen as a composition of three elements: processes, people and technology. Such a classification is not all embracing; it is rather an analytical apparatus, which will form various patterns of integration (see next section).

Human actors can be conceptualized as knowledge workers, who use their knowledge in order to produce particular services or products required for specific process. Technological actors also provide particular services for specific process, for instance, information transfer. Thus, both human and technological actors are service and product providers. Important to note, that neither human nor technology actor is viewed in a mechanical way, as latter outlined they both are strongly interrelated and have unforeseeable character.

Specific services of human and technology actors are used in particular processes. Process determines sequence of actions, which produce deliverables either service or product [4]. Processes are not limited to organization boundaries, they have cross-functional and cross-organizational character, meaning that they can be distributed along time and space dimensions. [4]. Definition of process entails not only those processes that are formally defined (canonical), but informal ones (noncanonical) as well.

The outlined elements have several characteristics. Some of these characteristics are based on [15] conceptualization of three problem dimensions of information systems integration. Characteristics are presented below.

Granularity (level of detail)

Each element can be analysed in particular level of detail. Cultivating zooming in and out perspective [18], granularity of analysis becomes flexible. In some instances, technological actor can be particular module, or large-scale infrastructure. Human actor can be also viewed as one human or community of humans (not necessarily community of practice). The same flexibility applies to processes. It implies that every element can be approached from certain level of granularity. Therefore, research focus and questions would determine the level of granularity.

Stable – dynamic

Each element has properties of stability and dynamics. For instance, particular process can become stable over the time, but at the same time it has continually adapt to internal or external organization changes. Technologies have emergent properties [32], while human actor has unpredictable character also. Thus, all elements continually change and have unforeseeable character.

Distribution – Centralization

All three elements can be to certain extent geographically distributed or centralized. Elements can be

centralized into one location or geographically dispersed in different locations. Considering large-scale organizations, each element, depending on the granularity level, could be conceptualized as both distributed and centralized.

Heterogeneity - Homogeneity

Considering technological element, there could be different hardware platforms, operating systems, database management systems, and programming languages [15]. In smaller contexts, technological element would be more homogeneous. All human actors are to some extent heterogeneous – they have different ethical and cultural backgrounds, knowledge, specialization, attitudes or aims. This characteristic also applies to processes.

Autonomy – Dependency

Every element has endless number of dependency links [18]. As mentioned, granularity of analysis is flexible, therefore particular actors or processes could be seen as self-sufficient and independent. However, the main focus of this characteristic is not to identify that dependency exists, but to conceptualize the dynamics of dependency.

4.2. Patterns of integration

Considering the above identified three elements, this section presents the patterns of integration. The primary aim is to outline analytical lens to analyse and explain integration activities associated with IT-related change.

4.2.1. Integrating technology with human actor

This pattern of integration concerns how technologies are integrated with particular communities [33]. The main research focus is how particular IT are institutionalized. For instance, Orlikowski [25] analyses how Incident Tracking Support Systems is implemented in Customer Support Department. This study does not explicitly address issues of integration, but the focus is, how human actors use new technology, what difficulties they encountered, how technology is worked around and why process of integration results in unintended consequences.

Studies focusing on appropriation of IT could also be seen as integration of human and technology actor. For instance, Walsham and Sahay [35] analyse how Geographical Information System is appropriated in India and underline that information technology with inscribed Westerns interests is difficult to appropriate in non-Western contexts.

Another possible way to analyse how technologies are integrated with human actors is to consider the notion of ‘enactment’. Orlikowski [26] proposes a practice-oriented perspective of recursive interaction between people and technologies. The main idea is that technologies are enacted, but the use is always emergent and situated, rather than stable.

Literature, which focuses on how particular technologies are used, underline that integration process is difficult, various side effects are produced and the use of technologies tend to drift from plans. This implies that integration of human and technology actors is difficult, never automatic and inherently produces unforeseeable consequences. However, reasons, why particular unintended consequences are produced, are context and time dependent, meaning that it is difficult to generalize and 'transport' implications between different research sites.

4.2.2. Integrating human actors

This type of integration concerns integration of human actors within or across organizations. Communities of practice (CoP) or ad-hoc types of integration between human actors are the focus of this integration pattern. CoP are groups of human actors who share a concern or a passion for something they do. CoP are not necessarily formal arrangements of human actors: "we belong to several communities of practice at any given time. And the communities of practice to which we belong change over the course of our lives. In fact, communities of practice are everywhere" [38, p.6]. This conceptualization underscores that human actors are integrated with formal or informal groups, but these are neither stable nor easily to establish.

Human actors could be integrated not necessarily as CoP, but as well as temporary formal project groups or ad hoc arrangements. The former concerns typical organization structure, which is established to deliver particular outcome during particular period. The latter could be illustrated how organization actors are unintentionally integrated with customer. Such an example is illustrated by [29]. Authors analyse the dynamics of integrated information systems in global contexts and demonstrate how web-based interface that provided customers with instant updates influenced integration between customers and auditors [29, p.32]. This example represents emergent integration between human actors, where technology acted as a mediator.

Considering the process perspective, Peppard and Rowland [28, p.189-190] analytically discuss how human actors are integrated into teams, how companies are integrated with individual customer or customer organization and how organizations are integrated with suppliers.

4.2.3. Integrating technologies

This pattern of integration concerns integration of various information systems. McKenn and Smith [22] outline different targets of enterprise application integration and conceptualize several strategies how integration should be managed. More extensive account is provided by Linthicum [21], where four main categories of application integration are proposed: information-oriented, business process integration-oriented, service-oriented, portal oriented.

Information-oriented application integration

This type of integration concerns information exchange between two or more systems. There are four integration patterns in this approach: database, application, user interface, and embedded device. The first three patterns can be equaled to different integration levels (database, application interface, and user interface). Embedded device pattern concerns information integration from embedded device, for instance wireless devices.

Business process integration-oriented application integration

According to [21], this type of integration is the future of application integration. Business process integration can be seen as another layer of already existing set of processes and data contained within a set of application. The goal is not only to transfer information between applications, but also to integrate business processes. The central idea is the definition of common business process model. This model defines the movement of information and invocation of application services across many different systems, both within and across organizations. This approach also requires integration brokers, which are responsible to process and route defined business processes and messaging services, which move information between connected applications. Important to note that this approach is not distinct from information, service or portal oriented approaches it is seen as complementary.

Service-oriented application integration

This type of integration allows organizations to share common application services and information. The difference from information-oriented integration is that applications at this level share services rather than information. The advantage of such approach is reusability of services, efficiency in terms of fast development of new services, loose technology coupling and division responsibility between business and technical people [24]. While Linthicum [21] argues that development service-enabled interfaces might be expensive and not very attractive to business organizations, Newcomer and Lomow [24] argue that such approach will be dominant in the future.

Portal-oriented application integration

Portal oriented approach enables to view various external or internal information systems through a single-user interface application, which is most often web-browser. This type of approach is rather distinct from the above outlined ones, because the main focus is not real-time data integration or event driven business process integration, but externalization of information into single interface.

As illustrated above, technological approach to integration concerns specific approaches and methods how IS can be integrated. Chari and Seshadri [1] argue

for adopting standards-base integration solutions and provide overview of existing standards.

Surprisingly, despite the existing variety of technological approaches, Somerville [32] outlines that integration of sub-systems into complete system inherently produce emergent properties, which cannot be understood by analysing individual system components. Therefore, the aim to achieve seamless integration is already questioned at the technical level: “it is not always possible – and even not always reasonable – attempting to eliminate autonomy, heterogeneity, or distribution entirely” [15, p.37].

4.2.4. Integrating processes with human actors

Particular processes require certain human actor activities, such as execute, perform or complete particular action or the whole process. Considering formal definitions of process schemes, which define human actions executed in particular sequences, it is also important to note that ‘work around’ [8] can also be treated as particular action of process. Thus, particular process would require human actor to perform both formal (canonical) and informal (noncanonical) activities. Considering CSCW literature, several studies present that in large-scale contexts, formal processes fail to be appropriated, implying that work processes have to be flexible and support local practices. Another interesting analytical aspect of this pattern is to consider how particular human actor is integrated with distributed processes.

4.2.5. Integrating technologies with processes

As previously outlined, the process in this paper encapsulates not only formal definitions. In turn, process can be completely or partly embedded in particular technology. For instance, broadly recognized approach to streamline processes is ERP monolithic structure. In such case, processes are standardized, defined by vendor [5] and as result “most companies must first reengineer their business processes to adopt ERP standard business processes” [20, p.56]. As already mentioned, such standard processes embedded in technology produce side effects, do not fit to all contexts [31] or are not compatible at all with existing organization work practices [20].

An alternative strategy is to rely on less technology embedded and less standardized approach. Such an approach concerns distribution and supports uniqueness. Then, processes are more customer, quality, or efficiency oriented, rather than technology driven.

The distinction between two approaches would certainly suggest that business processes should determine type of IS, but such tension is neither easily solvable nor context independent. Both approaches possess certain risks and promises.

4.2.6. Integrating processes

Process can be approached from varying degree of granularity; therefore sub processes are always formally integrated: “processes can be applied to both large and small processes – to the entire set of activities that serve customer, or only to answering a letter of complaint” [4, p.7]. Processes are interdependent when deliverable of one process is required for another, or inputs of one process serve several processes [28]. For instance, the notion of ‘shared care’ strongly leans to integration of geographically distributed services. However, recent studies show that such a seamless integration is hardly achievable in large contexts, where local processes are different from the ones embedded in technology [7].

5. Discussion: implications for conceptualizing integration activities

Traditionally the term ‘integration’ is associated with the technology-to-technology pattern of integration. However, as [10, 15] suggest it is not always possible and not always reasonable to integrate information systems. Possible impacts of integration should be carefully analysed beforehand [10]. Moreover, considering both small and large contexts, integration activities can lead to various side-effects [14, 32]. Integration efforts produce context and time specific results and pure technological solution might not be sufficient to achieve specific goals. Analysing how particular technologies can be integrated in specific community is important, but the need and suitability of particular integration method should be recognized also [10]. This leads to question what has to be integrated, why and what outcomes (intended and unintended) could be achieved.

Then, the focus shifts to the process perspective, for instance how particular processes could be improved and integrated with human actor, technical actor or both (arrangement of human and technical actors). Therefore, socio-technical nature of integration activities should be recognized [33]. This would concern how technologies are integrated with particular communities.

The proposed patterns of integration aim to contribute to such interdisciplinary analysis of integration activities in organizations. The main idea is that integration activities should be placed in complex and dynamic socio-technical contexts. It requires not only analysing how technologies are integrated, but also how integrated technologies are integrated with existing organizational contexts. Moreover, integration efforts should be analysed from ‘process perspective’, which concerns how technologies influence particular processes or how human actors enact specific work processes.

Important to note that the presented patterns do not lean neither to tight nor to loose forms of integration, instead then provide an analytical perspective how

interdisciplinary integration efforts can be analysed and explained. Analysis is flexible and research focus dependent. We acknowledge that the proposed patterns are analytical rather than empirically grounded ones. Therefore, both empirical and analytical discussions, considering the validity of the proposed taxonomy, are welcome.

Consequently, we propose that more research is needed to conceptualize interdisciplinary integration processes and consequences.

6. Conclusions

Integration process is neither completely rational nor purely technical [34]. Technological integration does not automatically improve or establish new efficient ways of working. It is continuous negotiation process between various actors with hardly predictable trajectory [18]. The decision, which type of integration should be implemented in particular organization is neither obvious nor objective [10]. Integration efforts change existing patterns of communication or information sharing between particular communities [33], but both short and long-term consequences are difficult to predict [10].

This paper has illustrated existing ambiguity associated with the term 'integration' and need for more systematic and interdisciplinary conceptualizations. The developed taxonomy proposes a direction to conceptualize interdisciplinary nature of integration activities and contributes to the development of interdisciplinary [27] theoretical perspectives [11].

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